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R. C. Butman

The Lincoln Terminal System (LTS-5) A Brief Description

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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FOR THE COMMANDER

Raymond L. Loiselle

Raymond L. Loiselle, Lt. Col., USAF
Chief, ESD Lincoln Laboratory Project Office

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
LINCOLN LABORATORY

THE LINCOLN TERMINAL SYSTEM (LTS-5)
A BRIEF DESCRIPTION

R. C. BUTMAN

Group 27

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Abstract

The LTS-5, a self-contained, computer mediated training system, presents audio messages and visual images to a trainee and interprets the trainee's response which is entered via a keyboard. The basic subsystems of the LTS-5 are outlined, and the format of the student-machine interaction is described. The required support facilities are discussed. Several pictures of the LTS-5 are included. This report is an update of TN-1972-26*.

* R.C. Butman and F.C. Frick, "The Lincoln Training System: A Summary Report," Technical Note 1972-26, Lincoln Laboratory, M.I.T. (3 October 1972), DDC AD-750748.

THE LINCOLN TERMINAL SYSTEM
(LTS-5)
A BRIEF DESCRIPTION

A. INTRODUCTION

The Lincoln Terminal System (LTS) is an interactive training system which, under the control of a microprocessor, presents visual images and audio messages to a user and responds appropriately to keyboard inputs. It is a self-contained equipment -- only AC power need be supplied for its operation. The basic information storage medium is microfiche. Visual images on the fiche are stored and projected in a conventional manner. Audio is stored on the fiche as a width-modulated track, similar to that used in motion picture film except that the dimensions are smaller and the track is stored as a spiral. See Figure 1. A unique photodiode is used to read the audio spiral. Lesson control logic, which enables the terminal to make appropriate responses to student keyboard selection, is also recorded on each audio spiral preceding the audio message.

The LTS stores up to 750 microfiche in a carousel. Each fiche holds up to 12 visual images and a corresponding number of audio/logic spirals; the storage capacity of the system is, therefore, $12 \times 750 = 9000$ audio/visual images.

In operation, an interaction sequence begins with the presentation of a visual image to the student. Simultaneously, the control logic associated with the visual image is read into the microcomputer from the audio/logic spiral. Following the logic read-in, the audio message is presented to the student. The student then responds to the audio-visual presentation through the LTS keyboard. The keyboard permits the student to enter numerical answers and to respond to simple or compound multiple-choice questions, where a compound choice is defined to be more than one choice, ordered or unordered from one or more lists of choices. The LTS then

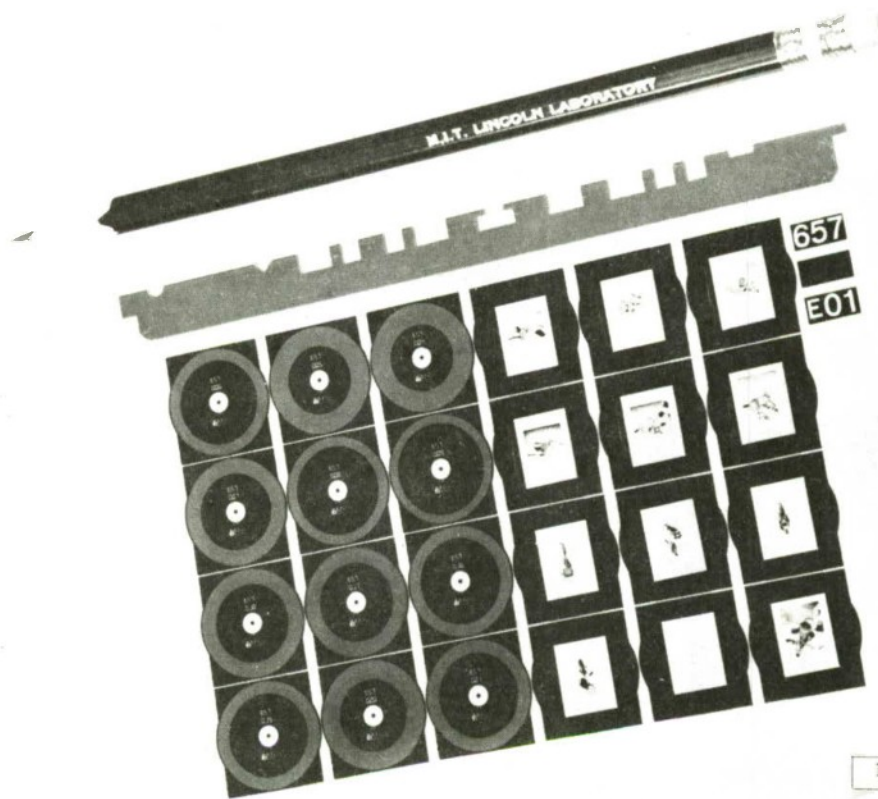


Fig. 1. Audio/graphic fiche.

responds by branching to another fiche as directed by the stored program, the frame control logic, and the user keyboard input.

Figures 2, 3 and 4 and 5 are pictures of the equipment and the keyboard.

B. LTS-5 Subsystem Description

1. General

The LTS-5 performance and physical characteristics described are achieved with the aid of eight subsystems described below. Figure 6 is a block diagram of the eight LTS-5 subsystems. These subsystems are described in the following paragraphs:

2. Fiche Manipulation

The Fiche Manipulation subsystem consists of the necessary mechanisms to select any one of up to 750, 4- x 6- in. microfiche (with designation 1 through 999) stored in the carousel and coarse position that fiche so that the selected audio and visual frames are in the control range of the fine-positioning mechanism. The fine-positioning mechanism then acts to move the fiche so that the selected audio spiral can be read by the Audio Reader (Figure 7).

The Fiche Manipulation system responds automatically to computer-generated select commands which are activated by student keyboard inputs. The Fiche Manipulation system also responds to fiche select commands which are entered via the manual control panel. The basic fiche storage, the electromechanical selection mechanism, and the optical projection lens and mirrors use parts from the Image Systems Corporation CARD* Unit.

* Compact Automatic Retrieval Display -- a commercial microfiche display unit which selects fiche with a manual keyboard.



Fig. 2. LTS-5 in operation.

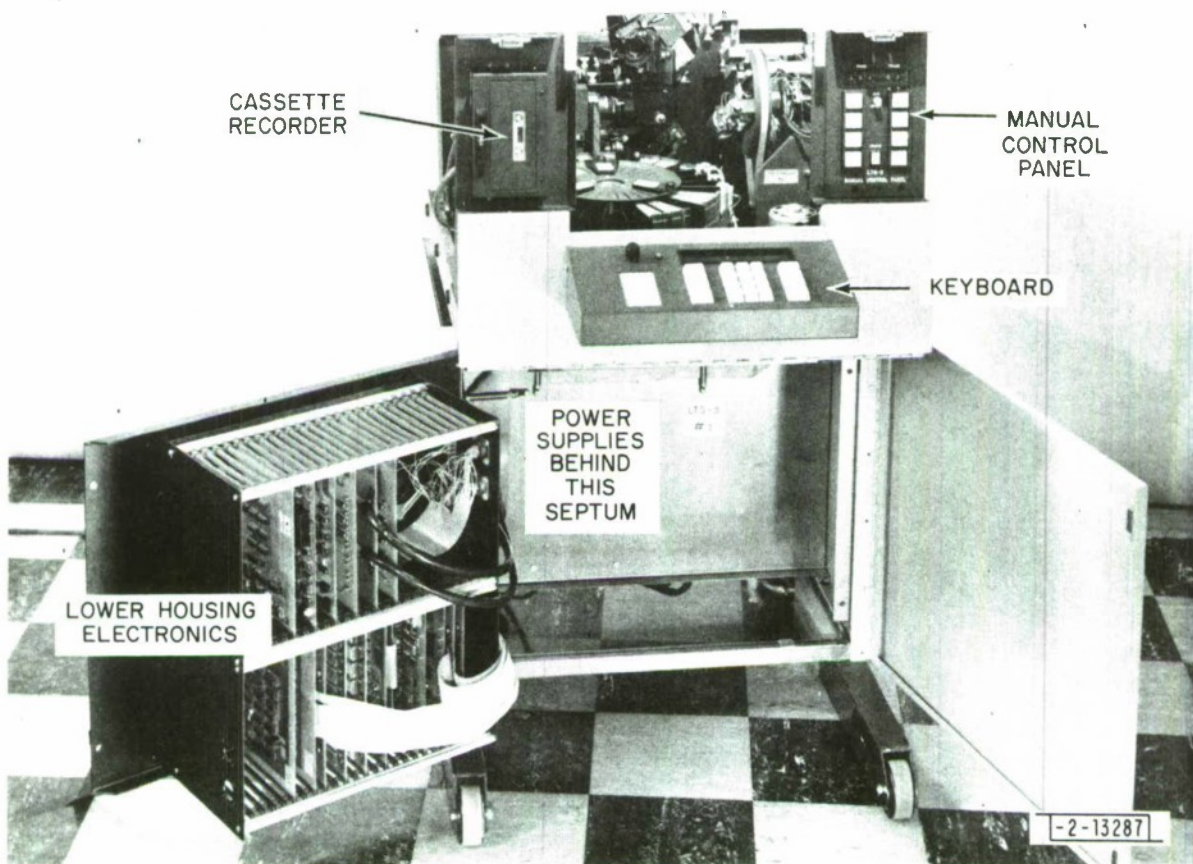


Fig. 3. LTS-5 open for inspection.

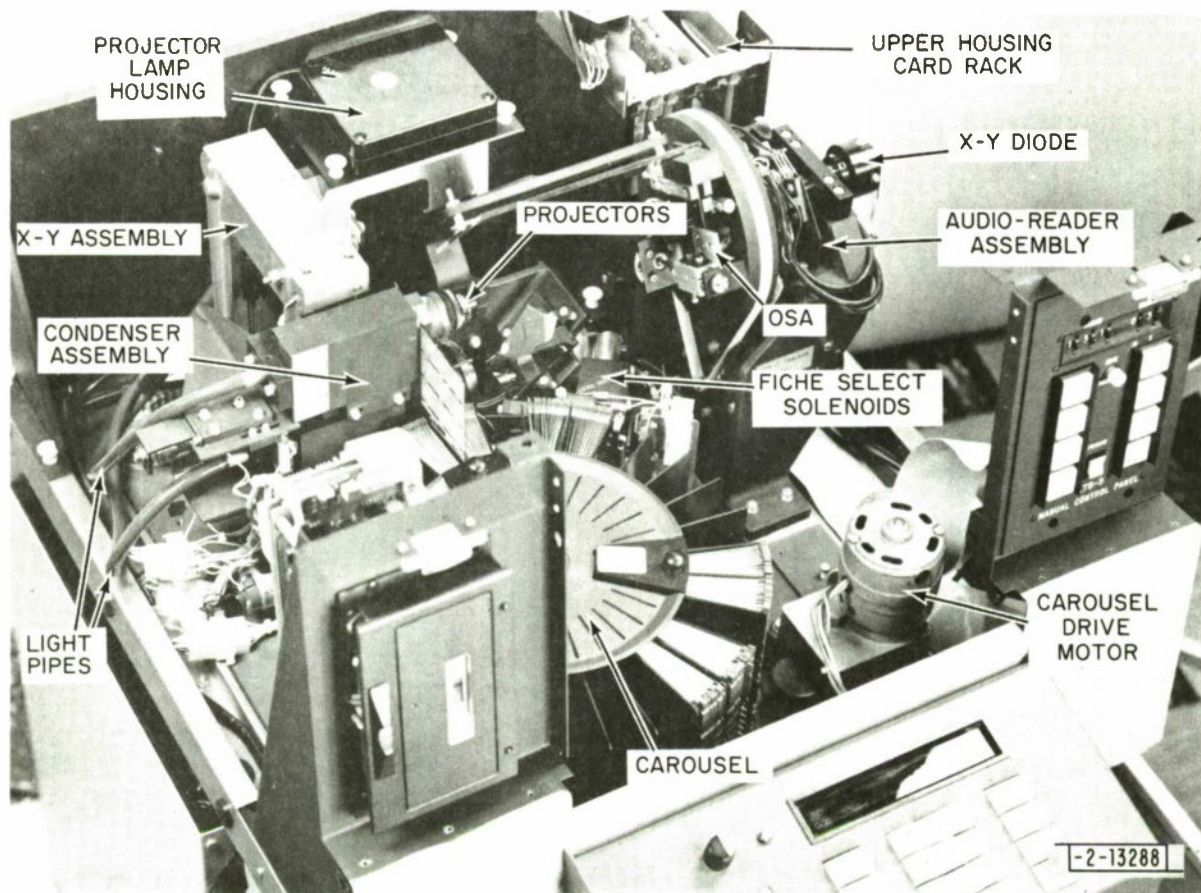
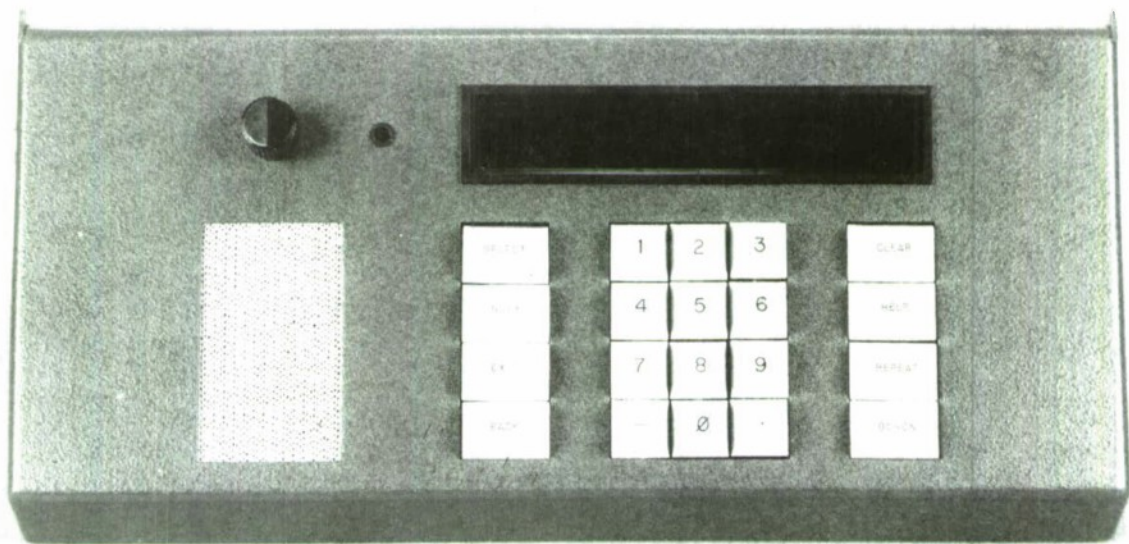


Fig. 4. Upper housing with cover off.



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Fig. 5. Keyboard.

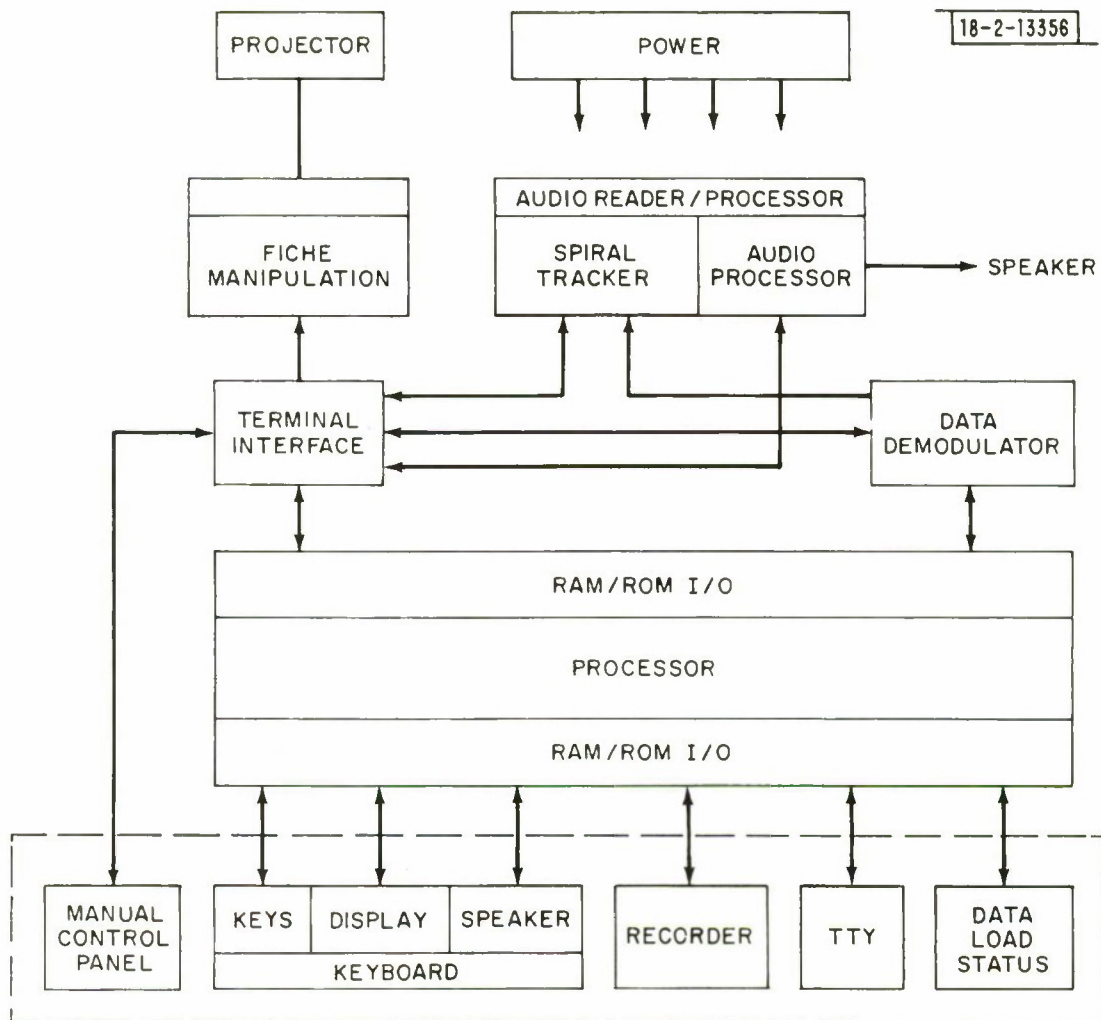
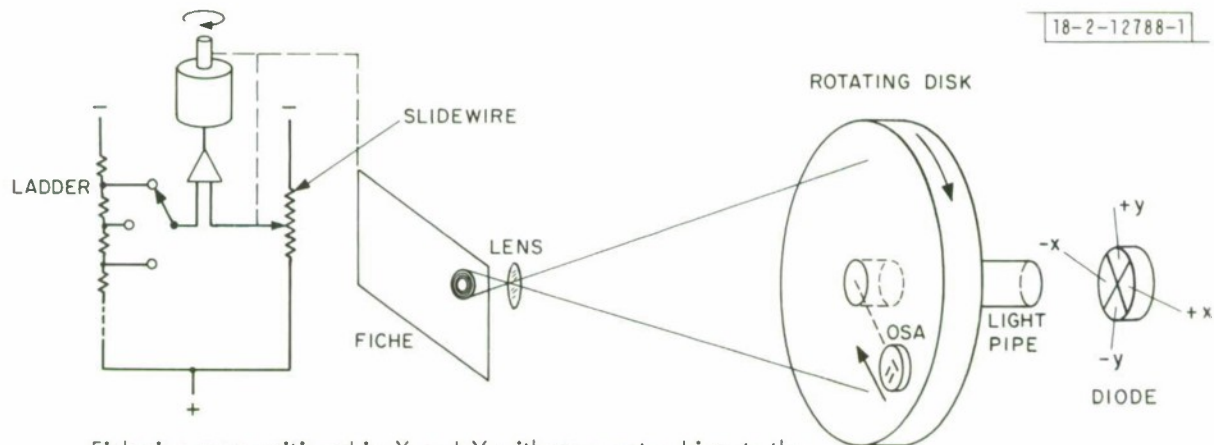
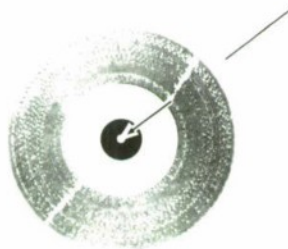


Fig. 6. Subsystems block diagram.



Fiche is coarse positioned in X and Y with servo motor drives to the desired spiral by matching the voltage on a slidewire attached to the fiche with a selected voltage on a divider. This moves the clear boresight of the selected spiral onto the fiber-optics light pipe which conveys the boresight image to an X-Y diode. The differential error voltages developed by the diode are then used to drive the servo motors in a fine positioning mode so that the boresight will be within about 0.06 mm overage, referred to the film plane, of the center of rotation of the reader.



Once fine positioning is completed, the optical sensor assembly (OSA) is activated. It moves along the audio-dot track by virtue of its location on the rotating disk of the reader. It maintains its position of the center of the track by an inward radial motion, under the control of a servo motor whose error signal is derived from the track sensing diodes on the OSA.

Fig. 7. Audio reader.

3. Audio Reader/Processor

The function of the Audio Reader is to detect the audio modulation on the audio/logic spiral, converting that modulation into audible telephone-quality audio and transmitting the logic signals to the Data Demodulator.

4. Data Demodulator

The function of the Data Demodulator is to extract timing information and data (lesson logic) from the Audio Reader output signal and transmit it to the Terminal Interface.

5. Terminal Interface

In response to commands from the Digital Processor, the Terminal Interface generates timing and control signals to operate fiche and frame selection, control the X-Y positioning, Audio Reader tracker and the audio data subsystems.

6. Digital Processor

The Processor decodes data received from the spiral via the Data Demodulator and Terminal Interface, interprets student responses entered through the keyboard, and transmits control signals to other subsystems. The processor uses an Intel 4040 CPU; it exercises control over all terminal I/O functions. It controls the selection and presentation of a given frame in accordance with (a) its stored program, (b) frame specific data read into RAM from the audio spirals, and (c) keyboard inputs. It also controls the flow of I/O data to a teletype and a digital cassette recorder. The Processor schedules and transmits enabling commands to:

- (a) Select a fiche
- (b) Select a frame (one of the 12 images on the fiche)
- (c) Control video on/off
- (d) Control audio on/off
- (e) Turn student keyboard error light on/off

- (f) Activate keyboard display
- (g) Control the audio tracker
- (h) Control TTY I/O
- (i) Control Cassette Recorder (to record keyboard actions)

The Processor decodes and responds to serial data input from the audio spiral and to keyboard data input from the student keyboard. The Processor accepts clock flag inputs from the interval timer.

7. Optical Projection

The Optical Projection system is a two-lens system which projects the audio spiral onto the image plane of the Audio Reader and its associated visual image onto a rear projection visual display. The two projection lenses are spaced so that when one is centered on an audio spiral image, the other is centered on the associated visual image.

8. Control and Recording

The user interacts with the LTS-5 through the Keyboard or the Manual Control Panel.

The keyboard allows entry of numbers 0 through 9, minus sign, decimal point, and 8 functions. Invalid entries are signalled by a red light on the keyboard. The audio speaker, earphone jack, volume control, and 10-digit LED display are also part of the keyboard assembly.

The Manual Control Panel contains an on-off switch, system reset, fiche select controls, fiche unload control, and audio repeat and focus control.

The maintenance panel uses a 10-digit LED indicator to display digits 0 through 9 which signify the status of the data load.

A Sycor magnetic tape cassette recorder model 135 is used to record all user keyboard actions for later analysis.

A teletype, not part of the LTS-5, is used as a maintenance aid. A TTY interface is, therefore, provided as part of the LTS-5.

9. Power Conversion

The Power Conversion system converts 110V AC into the DC and AC voltages required to operate the various subsystems.

C. Author Programs

The LTS processor supports several standard Author Programs and it can be reprogrammed to accommodate new ones as needed. The author programs are of two basic forms -- non-branching and branching. Non-branching programs are used when the author does not need to evaluate allowable keyboard inputs. These non-branching programs are supported by function keys -- GO-ON, HELP, BACK, INDEX, REPEAT and EXIT.

GO-ON	calls a (next) frame that has been pre-selected by the author.
BACK	calls a previous frame pre-selected by the author.
HELP	calls a frame designed to give extra assistance to the student in solving a problem.
INDEX	calls an Index.
REPEAT	replays the audio associated with the current frame.
EXIT	allows the student to leave the current lesson.

A CLEAR key allows the student to erase an entry.

Branching programs are used to evaluate student keyboard inputs in response to questions posed by the current frame. In all branching programs, the author designates, with his control logic, the next frame to be called by correct or incorrect responses. In some cases, varying degrees of correctness are recognized so that more than two branching frames may be available.

Branching Programs include:

NUMBER	accepts a student number input. Branches available for above, below and within tolerance.
ANYORD	asks the student to choose up to six items from a list of up to nine and enter these numbered choices. Branches for correct and incorrect.

FIXORD	same as ANYORD, but the choices must be in a specified order.
CHOOSE	asks the student to select a choice from a list of up to nine. Branches for each possible choice are provided.
QUIZ	evaluates answers up to six multiple choice questions on a single frame. Branches for High Pass, Low Pass and Fail.

D. LTS Utilization

The LTS is designed to teach facts, principles and computational skills. It can guide a user through maintenance or adjustment procedures, checking the accuracy of the student's actions at each step in a procedure. It has been used to teach basic electronics to Air Force trainees, Digital Systems Engineering to professional technical personnel, and maintenance procedures to Air Force Communications specialists.

E. Support Facilities

1. General

Support facilities available to date at Lincoln Laboratory are experimental. Under a current contract, these facilities -- author support, fiche production -- are being produced and documented in a form suitable for field use and for duplication.

2. Author Support

At this writing, author program logic for a given lesson are stored on punched paper tape. Corresponding audio messages are stored on magnetic tape. The author is provided with appropriate computer for making the logic tapes and audio recording facilities for recording the audio messages. A new system, now under development, records both audio and logic on a magnetic cassette tape. This new system will be operational in the spring of 1978.

3. Fiche Production

The audio and logic, associated with a visual presentation, are recorded as width-modulated spiral tracks on the microfiche. Visual frames are reduced in size and recorded as a conventional film image on the fiche. Conventional photographic facilities are required to place the images on fiche.

F. Summary

The LTS-5 is the first production engineered LTS equipment produced under the Lincoln Laboratory Educational Technology Program. As such, it is designed for reliable service and easy maintenance in field service. Complete electrical and mechanical and software documentation is available. It is our opinion that the LTS technology is now ready for incorporation, in moderate quantity, into job related training programs. As with any new technology, the initial operations must be constantly and critically evaluated so as to assure that the equipment is being used in a manner designed to produce greatest benefits to the user.

Lincoln Laboratory does not propose, at this time, any significant new LTS hardware developments, since it is believed that the equipment as now designed is well suited for its intended use. Should field evaluations reveal the need for changes, the Laboratory will propose appropriate action.

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